TRAIN SET: 01/01/2017 – 31/01/2017. DATA: AUTHOMOTIV STOCKS (

| BAJAJ.AUTO, | EICHERMOT, | HEROMOTOCO, | M.M | , MARUTI | ,TATAMOTORS |
| --- | --- | --- | --- | --- | --- |

)

WORKING WITH: LOG(OPEN/CLOSE) OF THE SAME DAY

TEST SET: FIRST 10 OBSERVATIONS AFTER 31/01/2017

| **Variable** | **Structural Break (Mean) [p-value]** | **Structural Break (Trend) [p-value]** | **ADF Test (None)** | **ADF Test (Drift)** | **ADF Test (Drift + Trend)** |
| --- | --- | --- | --- | --- | --- |

log\_ret\_BAJAJ-AUTO 0.1961 0.3308 < 2.2e-16 < 2.2e-16 < 2.2e-16

log\_ret\_EICHERMOT 1 0.6732 < 2.2e-16 < 2.2e-16 < 2.2e-16

log\_ret\_HEROMOTOCO 0.2659 0.4186 < 2.2e-16 < 2.2e-16 < 2.2e-16

log\_ret\_M&M 0.6158 0.08417 < 2.2e-16 < 2.2e-16 < 2.2e-16

log\_ret\_MARUTI 0.1943 0.001929 < 2.2e-16 < 2.2e-16 < 2.2e-16

log\_ret\_TATAMOTORS 0.3318 0.2978 < 2.2e-16 < 2.2e-16 < 2.2e-16

VAR lag 1 by minimizing the AIC

* roots of characteristic polynomial less than 1 in absolute value

| **Influenced \ Influencer** | **BAJAJ.AUTO** | **EICHERMOT** | **HEROMOTOCO** | **M.M** | **MARUTI** | **TATAMOTORS** |
| --- | --- | --- | --- | --- | --- | --- |
| **BAJAJ.AUTO** | 0.00165 | 0.93113 | 5.10e-06 | 0.15558 | 1.71e-10 | 0.33276 |
| **EICHERMOT** | 0.000345 | 2.12e-11 | 0.090496 | 0.587646 | 0.599411 | 5.82e-08 |
| **HEROMOTOCO** | 2.15e-08 | 1.09e-05 | 1.14e-14 | 0.9490 | 0.0117 | 0.8389 |
| **M.M** | 0.80592 | 0.03322 | 0.50074 | 1.59e-07 | 1.28e-07 | 0.68134 |
| **MARUTI** | 1.41e-05 | 0.020975 | 0.884291 | 0.497176 | 0.002877 | 0.000128 |
| **TATAMOTORS** | 0.71706 | 0.03284 | 0.59847 | 0.04023 | 0.00108 | 0.63694 |

Correlation of the residuals

|  | **BAJAJ.AUTO** | **EICHERMOT** | **HEROMOTOCO** | **M.M** | **MARUTI** | **TATAMOTORS** |
| --- | --- | --- | --- | --- | --- | --- |
| **BAJAJ.AUTO** | 1.00000 | 0.07164 | 0.21285 | 0.10676 | 0.11463 | 0.11064 |
| **EICHERMOT** | 0.07164 | 1.00000 | 0.10404 | 0.07279 | 0.08619 | 0.09700 |
| **HEROMOTOCO** | 0.21285 | 0.10404 | 1.00000 | 0.09802 | 0.10948 | 0.13271 |
| **M.M** | 0.10676 | 0.07279 | 0.09802 | 1.00000 | 0.12705 | 0.11346 |
| **MARUTI** | 0.11463 | 0.08619 | 0.10948 | 0.12705 | 1.00000 | 0.10772 |
| **TATAMOTORS** | 0.11064 | 0.09700 | 0.13271 | 0.11346 | 0.10772 | 1.00000 |

| **Stock (as cause)** | **Granger p-value** | **Instantaneous p-value** |
| --- | --- | --- |
| BAJAJ.AUTO | 9.663e-11 | < 2.2e-16 |
| EICHERMOT | 3.354e-05 | < 2.2e-16 |
| HEROMOTOCO | 8.506e-05 | < 2.2e-16 |
| M&M | 0.298 | < 2.2e-16 |
| MARUTI | 3.659e-13 | < 2.2e-16 |
| TATAMOTORS | 1.359e-08 | < 2.2e-16 |

Most stocks **significantly Granger-cause** the others suggesting **predictive influence** via lagged effects. Exception: **M&M** does *not* significantly Granger-cause others (p = 0.298), indicating it’s less influential over time.

**Instantaneous Causality**: All stocks have **highly significant instantaneous causality** (p < 2.2e-16), implying **strong contemporaneous co-movement** — likely driven by market-wide or sector-wide news/events.

This pattern reflects **tight integration within the auto sector**, where returns are influenced both **over time** and **simultaneously**.

RESIDUAL ANALYSIS

| **Test** | **Chi-squared** | **df** | **p-value** | **Interpretation** |
| --- | --- | --- | --- | --- |
| **Ljung–Box (Serial Correlation)** | 904.01 | 540 | < 2.2e-16 | ❌ Strong evidence of serial correlation — model residuals are not white noise. |
| **ARCH (Heteroscedasticity)** | 16660 | 2205 | < 2.2e-16 | ❌ Significant heteroscedasticity — conditional variance is not constant. |
| **Jarque-Bera (Normality)** | 5,283,973 | 12 | < 2.2e-16 | ❌ Residuals deviate significantly from normality. |
| **Skewness Component** | 20,078 | 6 | < 2.2e-16 | ❌ Asymmetry in the residuals — non-zero skewness. |
| **Kurtosis Component** | 5,263,895 | 6 | < 2.2e-16 | ❌ Excess kurtosis — heavy tails compared to normal distribution. |

Forecasting

A group of graphs showing the different types of data

AI-generated content may be incorrect.

* VARX model

NEW DATA: LAGGED VOLUME (AT T WE USE THE VOLUME OF T-1)

VARX RESULTS: SIMILAR TO VAR

| **Test** | **Test Type** | **Chi-squared** | **df** | **p-value** | **Conclusion** |
| --- | --- | --- | --- | --- | --- |
| Serial Correlation (Portmanteau) | Adjusted Portmanteau | 895.05 | 540 | < 2.2e-16 | Evidence of serial correlation (autocorrelation) |
| Heteroscedasticity (ARCH) | Multivariate ARCH | 16157 | 2205 | < 2.2e-16 | Heteroscedasticity present |
| Normality – Jarque-Bera (JB) | Multivariate JB | 5,296,819 | 12 | < 2.2e-16 | Residuals not normally distributed |
| Normality – Skewness Only | Multivariate Skewness | 19,005 | 6 | < 2.2e-16 | Significant skewness |
| Normality – Kurtosis Only | Multivariate Kurtosis | 5,277,814 | 6 | < 2.2e-16 |  |

A graph of different types of data

AI-generated content may be incorrect.

VAR slightly better

| **Variable** | **MSE** | **MAE** | **RMSE** | **Model** |
| --- | --- | --- | --- | --- |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| log\_ret\_BAJAJ.AUTO | 1.780683e-06 | 0.0011230423 | 0.0013344224 | VAR |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| log\_ret\_EICHERMOT | 4.216907e-06 | 0.0017726000 | 0.0020535109 | VAR |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| log\_ret\_HEROMOTOCO | 1.762276e-06 | 0.0011204812 | 0.0013275075 | VAR |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| log\_ret\_M.M | 4.138695e-06 | 0.0016855033 | 0.0020343782 | VAR |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| log\_ret\_MARUTI | 6.320145e-07 | 0.0005752949 | 0.0007949934 | VAR |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| log\_ret\_TATAMOTORS | 2.319612e-06 | 0.0012228173 | 0.0015230273 | VAR |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| log\_ret\_BAJAJ.AUTO | 1.800200e-06 | 0.0011337393 | 0.0013417154 | VARX |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| log\_ret\_EICHERMOT | 4.182223e-06 | 0.0017663340 | 0.0020450485 | VARX |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| log\_ret\_HEROMOTOCO | 1.764362e-06 | 0.0011213878 | 0.0013282931 | VARX |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| log\_ret\_M.M | 4.142367e-06 | 0.0016864982 | 0.0020352806 | VARX |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| log\_ret\_MARUTI | 6.373127e-07 | 0.0005784782 | 0.0007983187 | VARX |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| log\_ret\_TATAMOTORS | 2.325412e-06 | 0.0012223841 | 0.0015249301 | VARX |